XIX International Workshop on Deep-Inelastic Scattering and Related Subjects (DIS 2011)

Coherent deeply virtual Compton scattering off helium (CLAS)

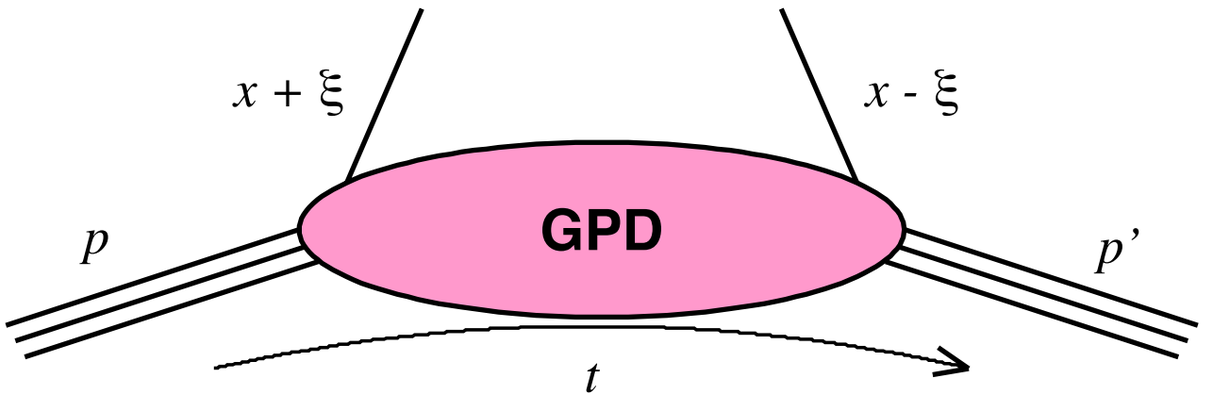
Yohann Perrin
LPSC Grenoble, France

On behalf the CLAS collaboration

LPSC Grenoble
Laboratoire de Physique Subatomique et de Cosmologie

Jefferson Lab
Thomas Jefferson National Accelerator Facility

Generalized Parton Distribution (GPD)



x : fraction of longitudinal momentum of the parton
ξ : difference between the longitudinal momenta of the incoming and the outgoing partons
t : transfered 4-momentum

A spin0-object can be described at leading order by one chirally conserving GPD, H_A.

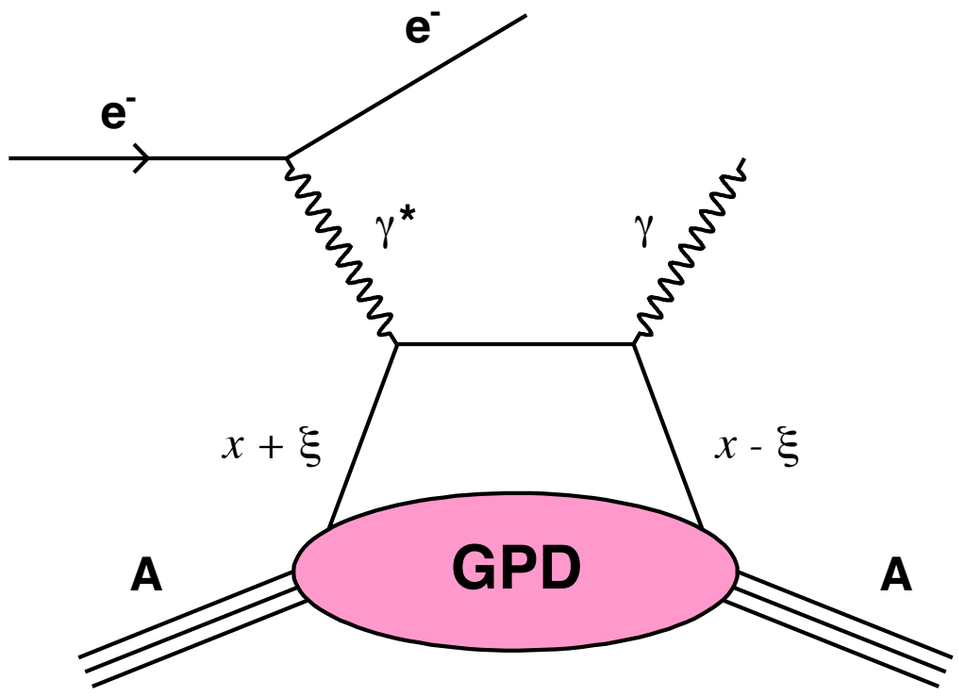
Link with form factor and parton distribution function :

$$H_A^q(x,0,0) = q_A(x) \qquad \sum_q e_q \int_{-1}^{1} dx\ H_A^q(x,\xi,t) = F_A(t)$$

Access to the spatial distribution of nuclear forces :

$$\int_{-1}^{1} dx\ x\ H_A^q(x,\xi,t) = M_2^{q/A}(t) + \frac{4}{5}\xi^2 d_A^q(t)$$

Deeply Virtual Compton Scattering (DVCS)



DVCS is deeply virtual electroproduction of a real photon ($Q^2 \gg M^2$ and $t \ll Q^2$).
It is the easiest way to extract GPDs.

DVCS accesses GPDs via the Compton form factors :

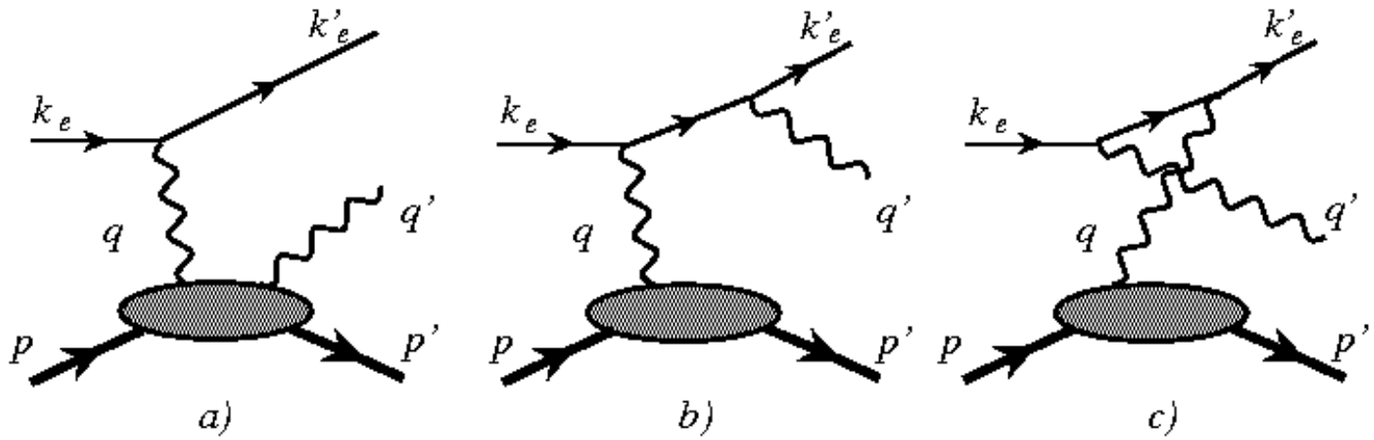
$$\mathcal{T}_{DVCS} \propto \mathcal{H}_A = \sum_q e_q^2 \, \mathcal{P}\{ \int_{-1}^{+1} dx \left(\frac{1}{x-\xi} \pm \frac{1}{x+\xi}\right) H_A^q(x,\xi,t)\}$$

$$-i\pi \sum_q e_q^2 \left[H_A^q(\xi,\xi,t) \pm H_A^q(-\xi,\xi,t)\right]$$

GPD

Electroproduction of the real photon

Interference between DVCS and Bethe Heitler



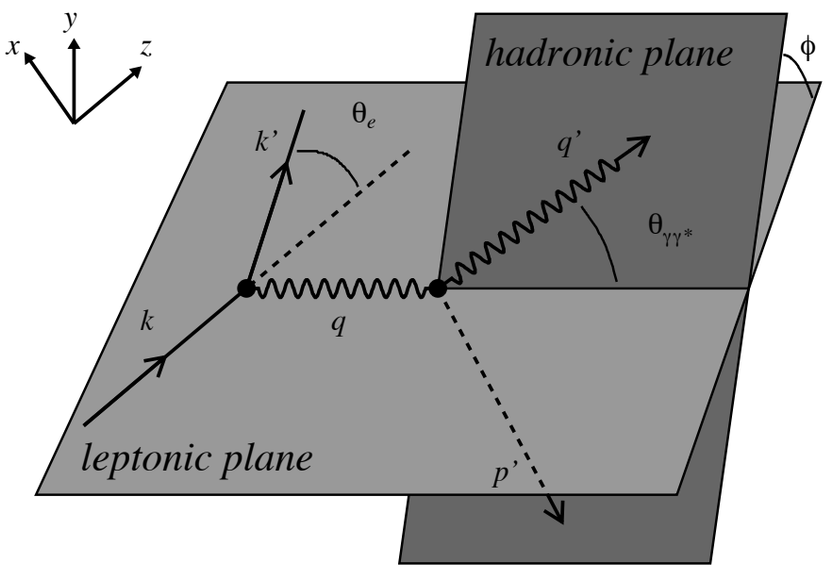
Cross section on an unpolarized target :

$$\frac{d^5\sigma^{\lambda}}{dx_A dQ^2 dt d\phi_e d\phi} \propto |\mathcal{T}_{BH}|^2 + |\mathcal{T}^{\lambda}_{DVCS}|^2 + \mathcal{I}^{\lambda}$$

beam polarization

ϕ-dependence of the beam spin asymetry :

$$A_{LU}(\phi) = \frac{d\sigma^{\uparrow} - d\sigma^{\downarrow}}{d\sigma^{\uparrow} + d\sigma^{\downarrow}}$$



Deeply Virtual Compton Scattering off 4He

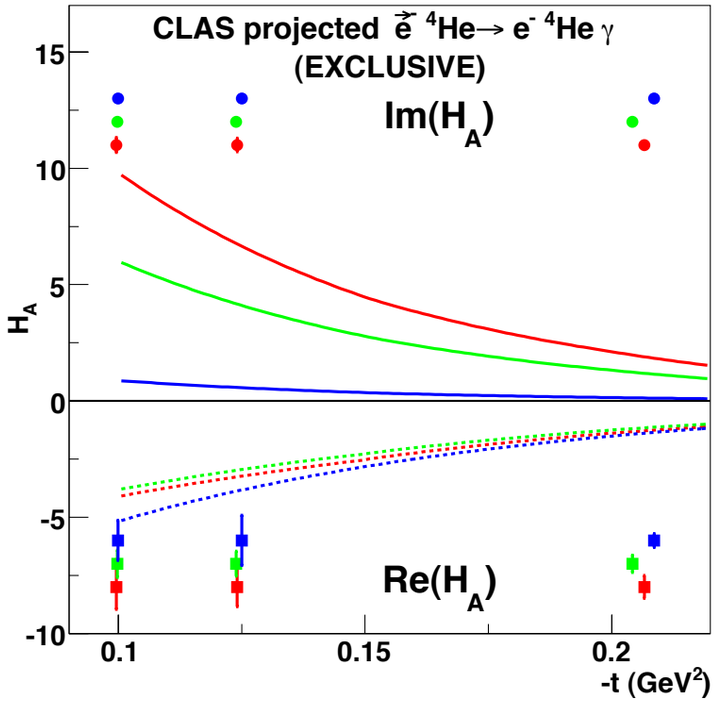
Coherent channel asymetry at twist-2 :

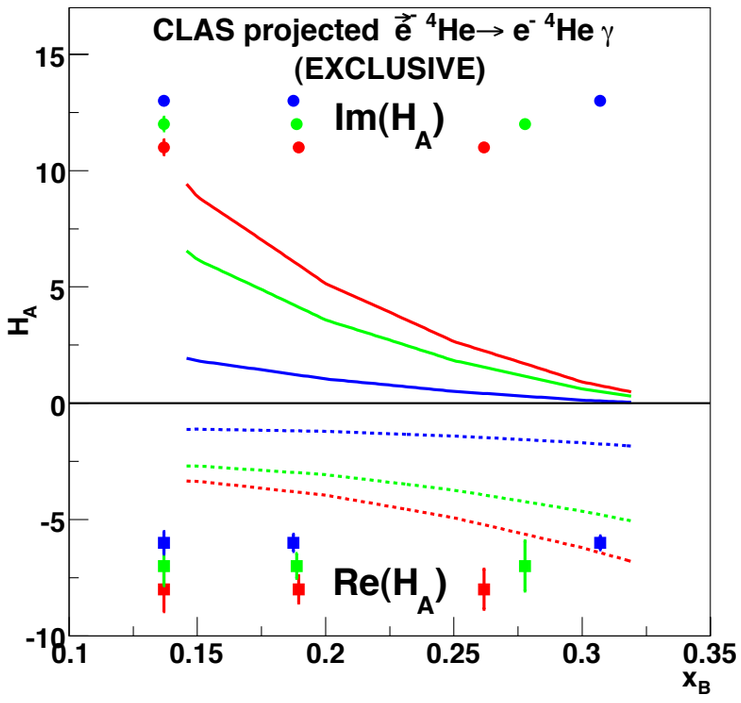
$$A_{LU}(\phi) = \frac{\alpha_0(\phi)\Im m(\mathcal{H}_A)}{\alpha_1(\phi) + \alpha_2(\phi)\Re e(\mathcal{H}_A) + \alpha_3(\phi)\left(\Re e(\mathcal{H}_A)^2 + \Im m(\mathcal{H}_A)^2\right)}$$

The ϕ-dependence of the beam spin asymetry allows to extract real and imaginary parts of Compton form factor.

In the region of the minimum of the helium form factor, a non-zero asymetry would probe twist-3 contributions.

proposal projections :



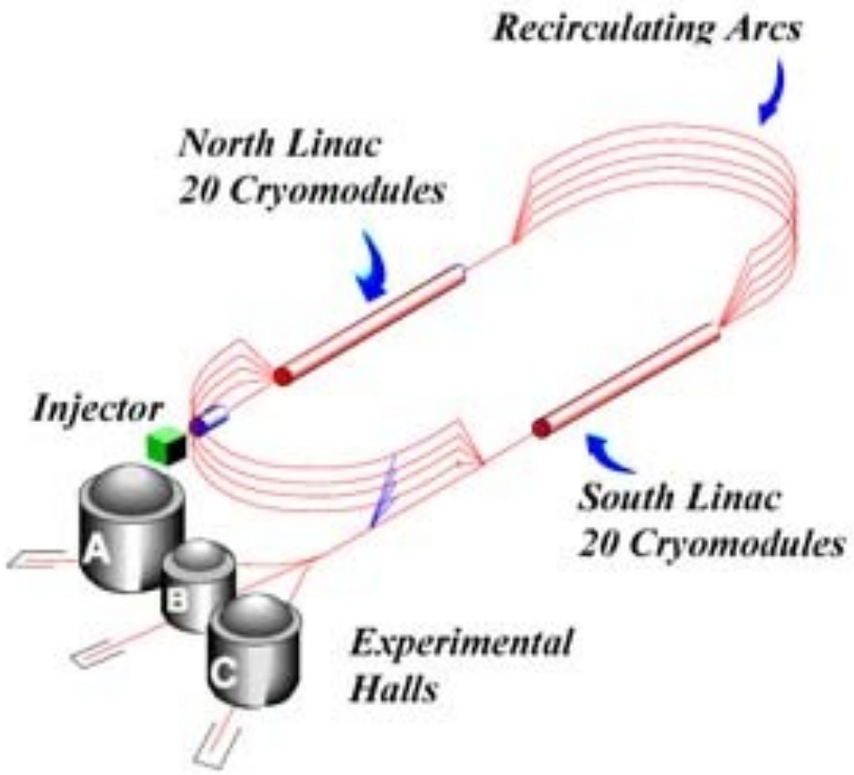


EG6

EG6 data acquisition occured during fall 2009, at Thomas Jefferson National Accelerator Facility (Newport News, VA). These data concern two experiments :

- Experiment 07-009 : Meson spectroscopy in the Coherent Production on 4He with CLAS
- Experiment 08-024 : Deeply Virtual Compton Scattering off 4He

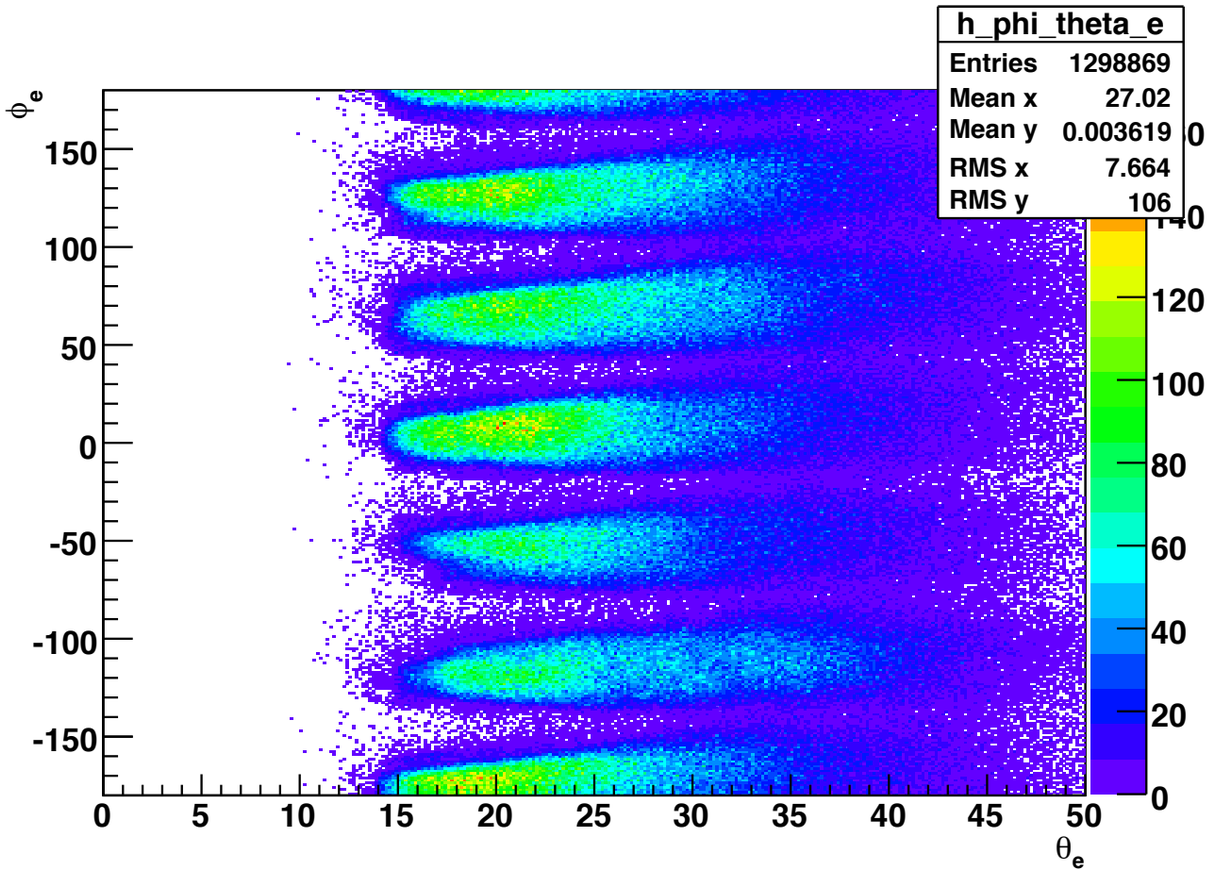
E = 6GeV
λ = 85%



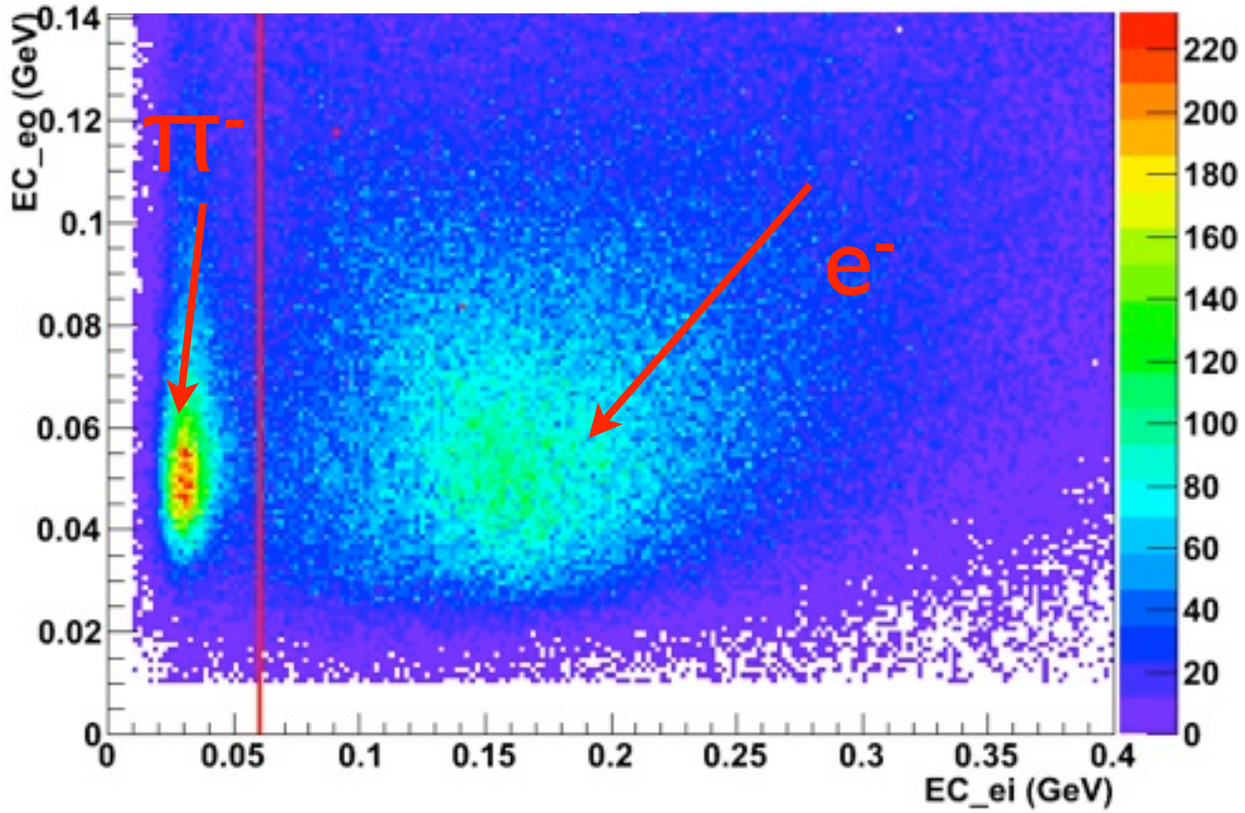
CEBAF

CLAS

Electron identification



electron phase space

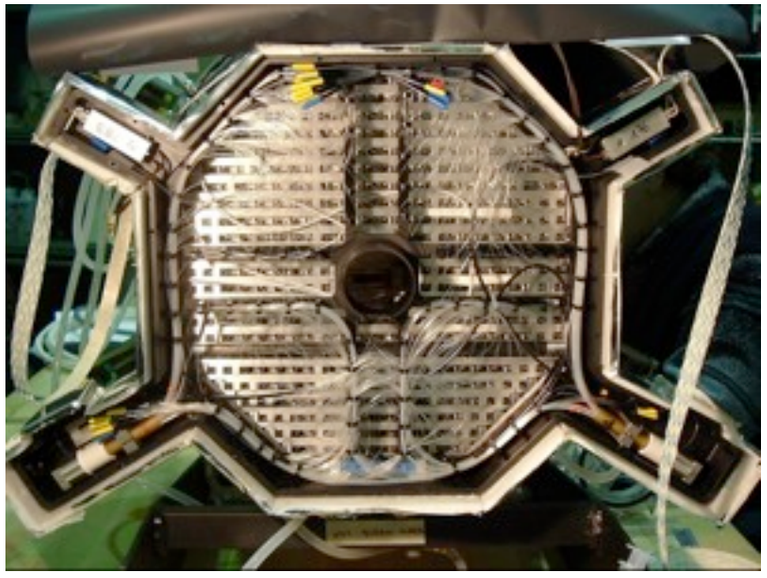


pion rejection

Electrons are detected with CLAS. Typical phase space shaped by the 6 CLAS sectors

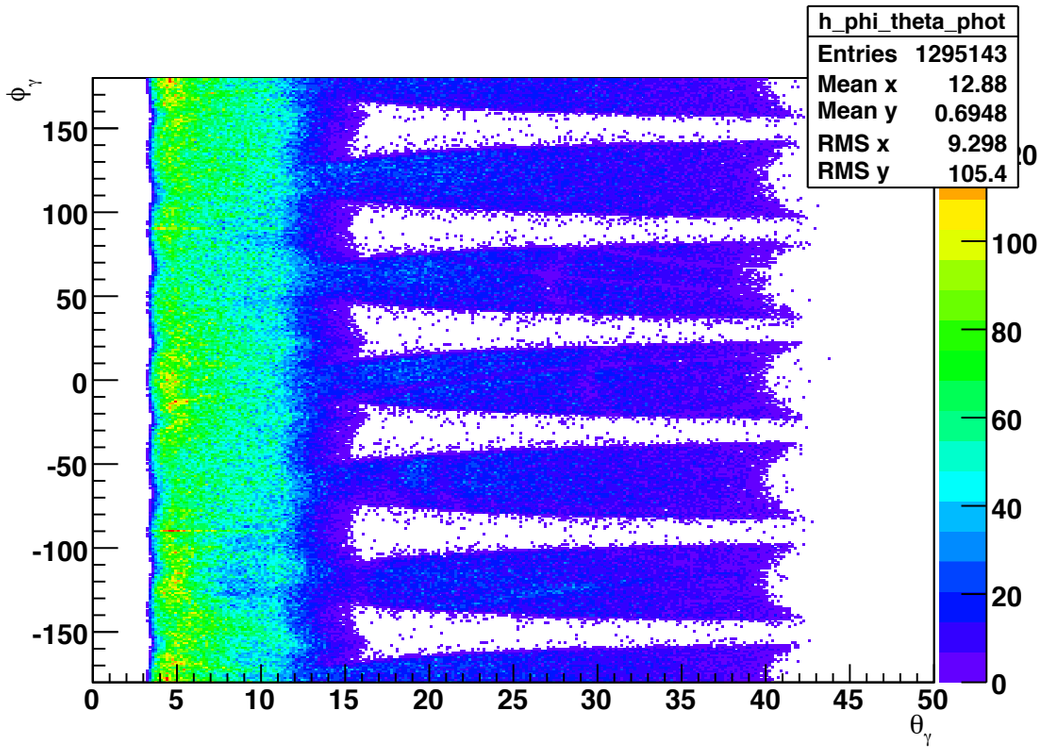
Pions are rejected with the Electromagnetic Calorimeter and the Cerenkov

Photon identification

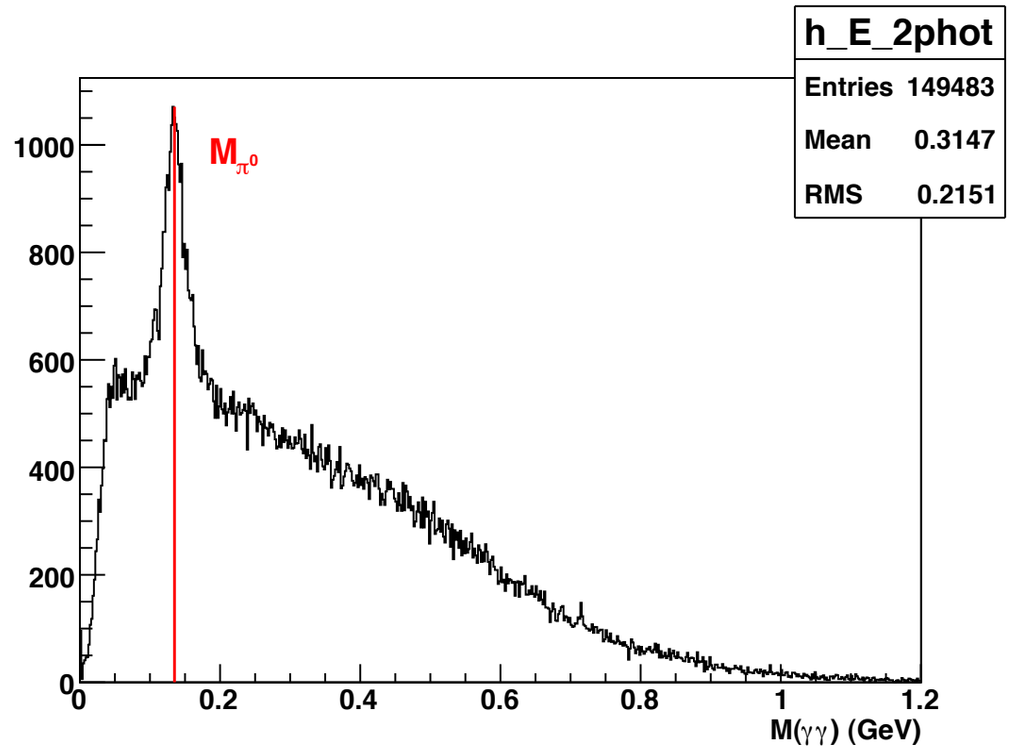


Inner Calorimeter

Photons are detected with the Electromagnetic Calorimeter (large angles) and the Inner Calorimeter (small angles)

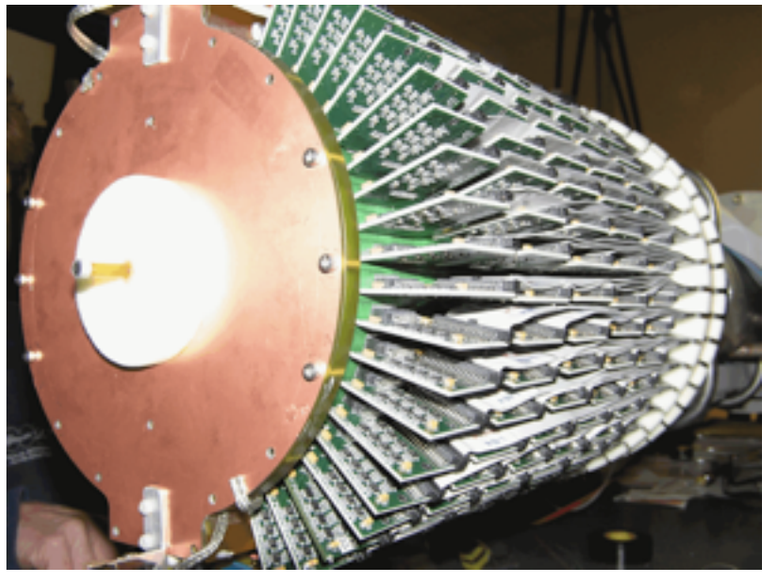


photon phase space



invariant mass of γγ events

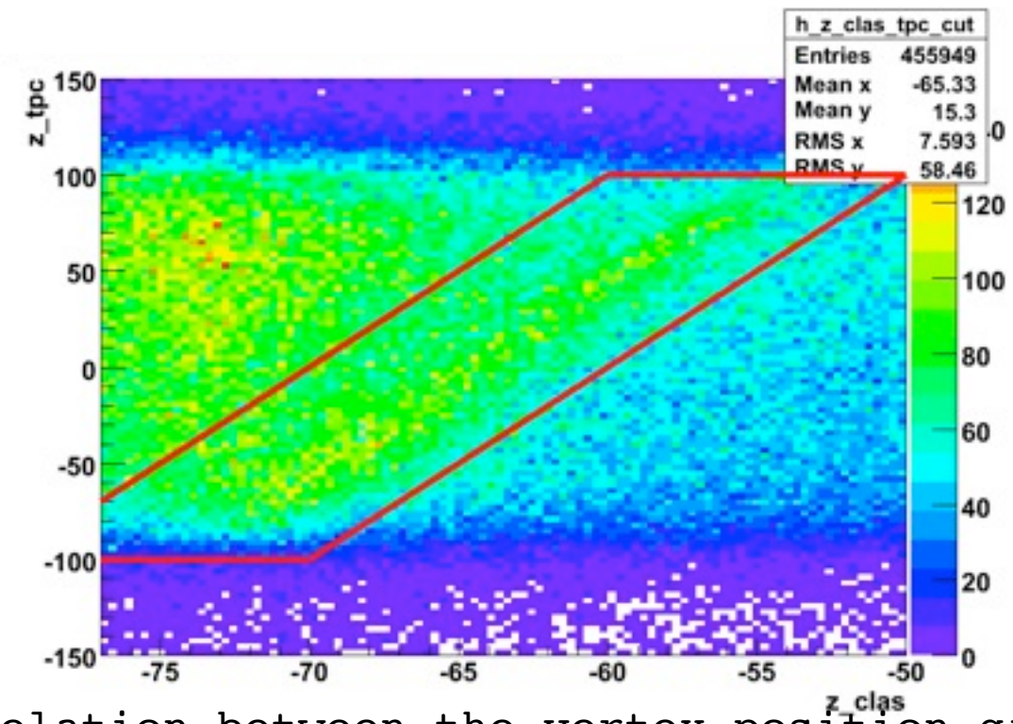
Helium identification



Radial TPC

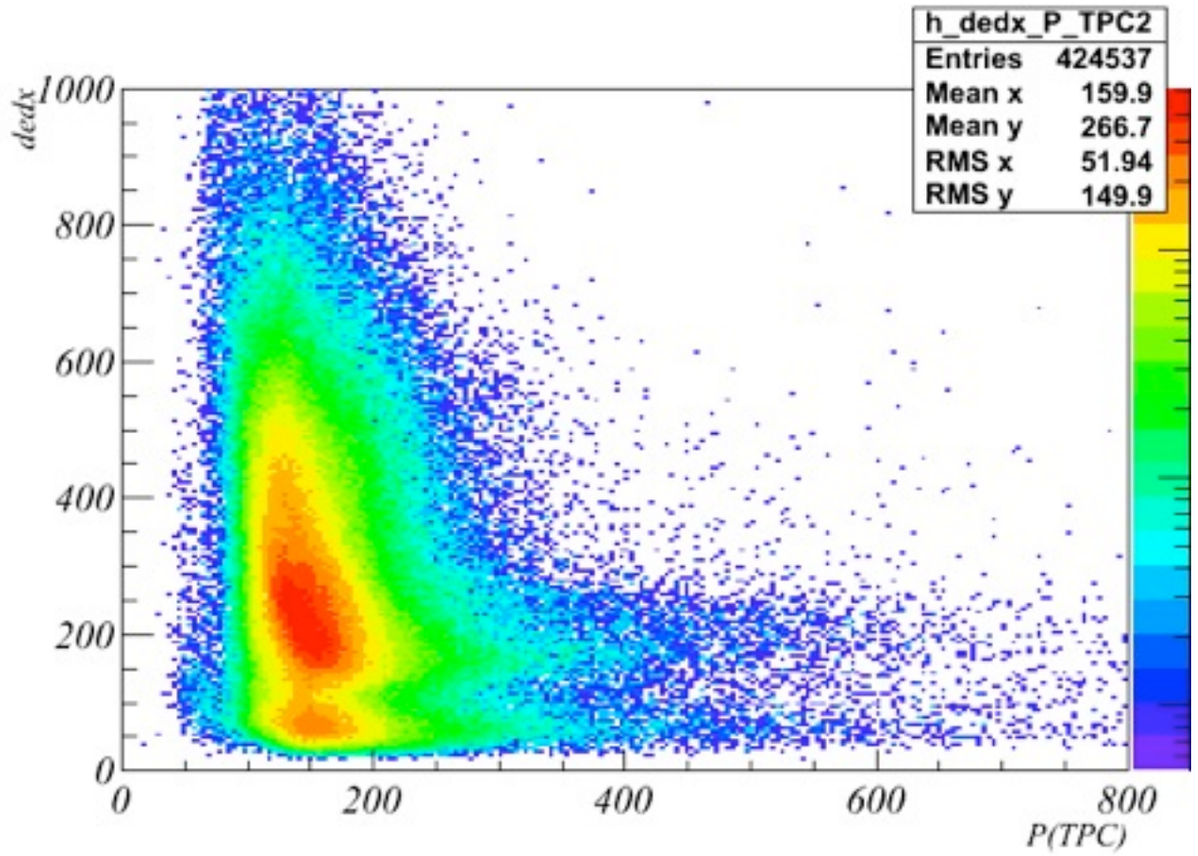
The RTPC detects helium nuclei and provides its momentum, angles, and the vertex position.

The calibration is being improved.



Correlation between the vertex position given by CLAS and the RTPC

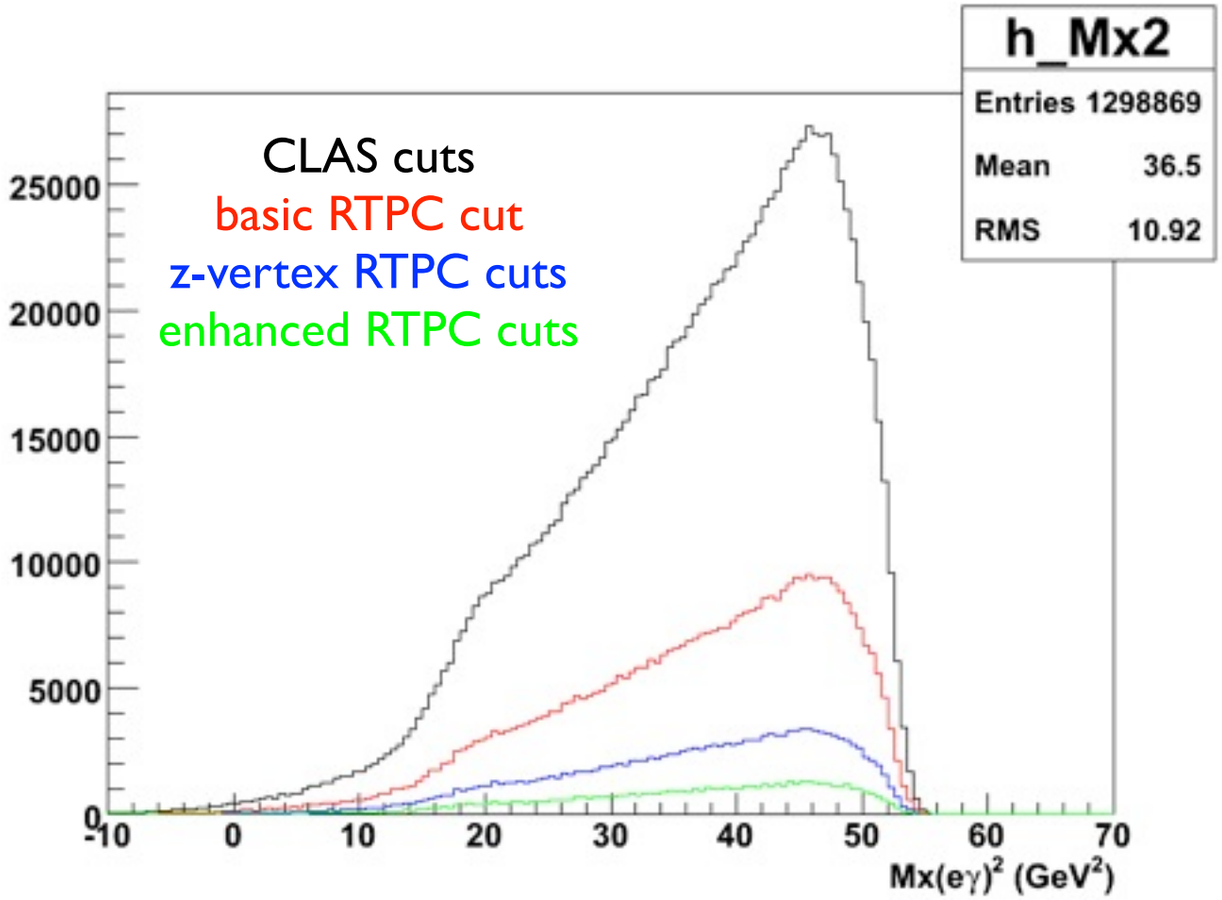
In red is the vertex cut applied



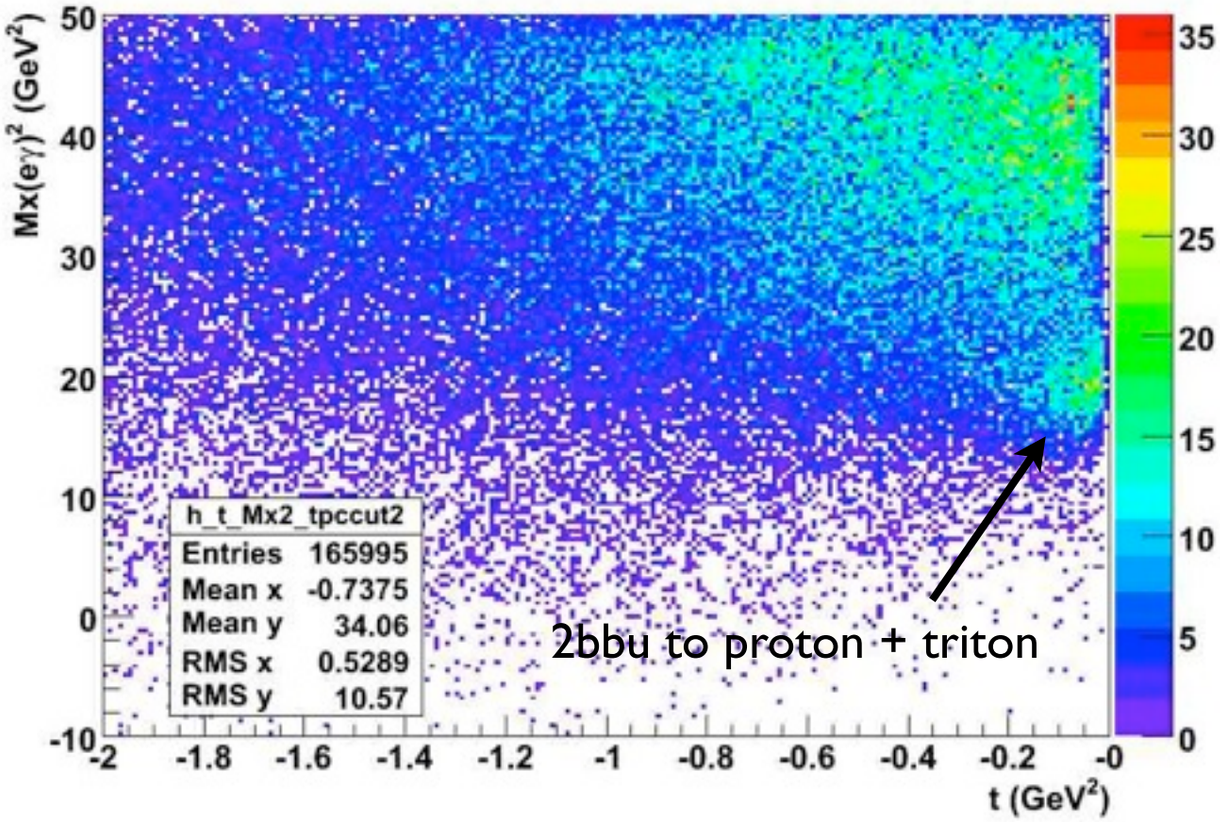
Elastic events at 1.2 GeV

Courtesy R. Paremuzyan

Current status of analysis



Missing mass of the electron + photon with different cuts



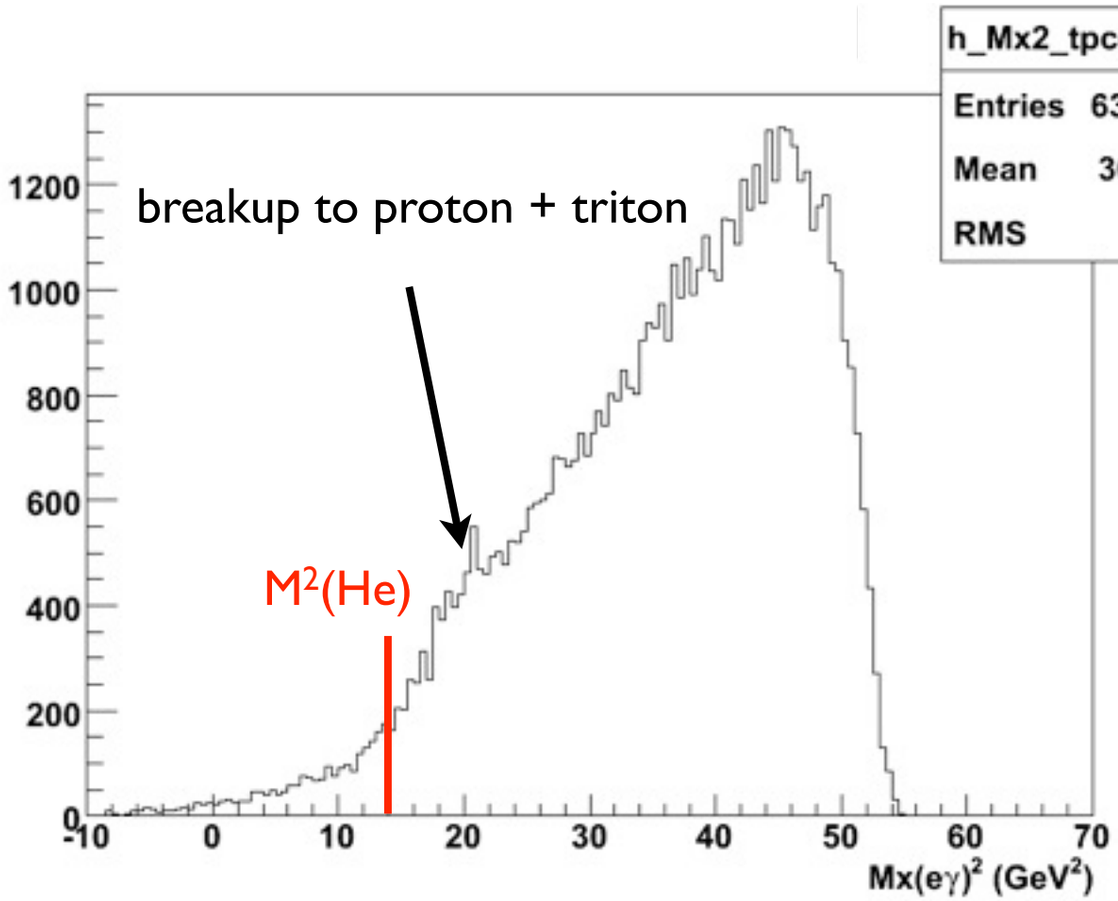
Squared missing mass of the electron + photon versus t

Cuts largely reduce the high missing mass part of the spectrum

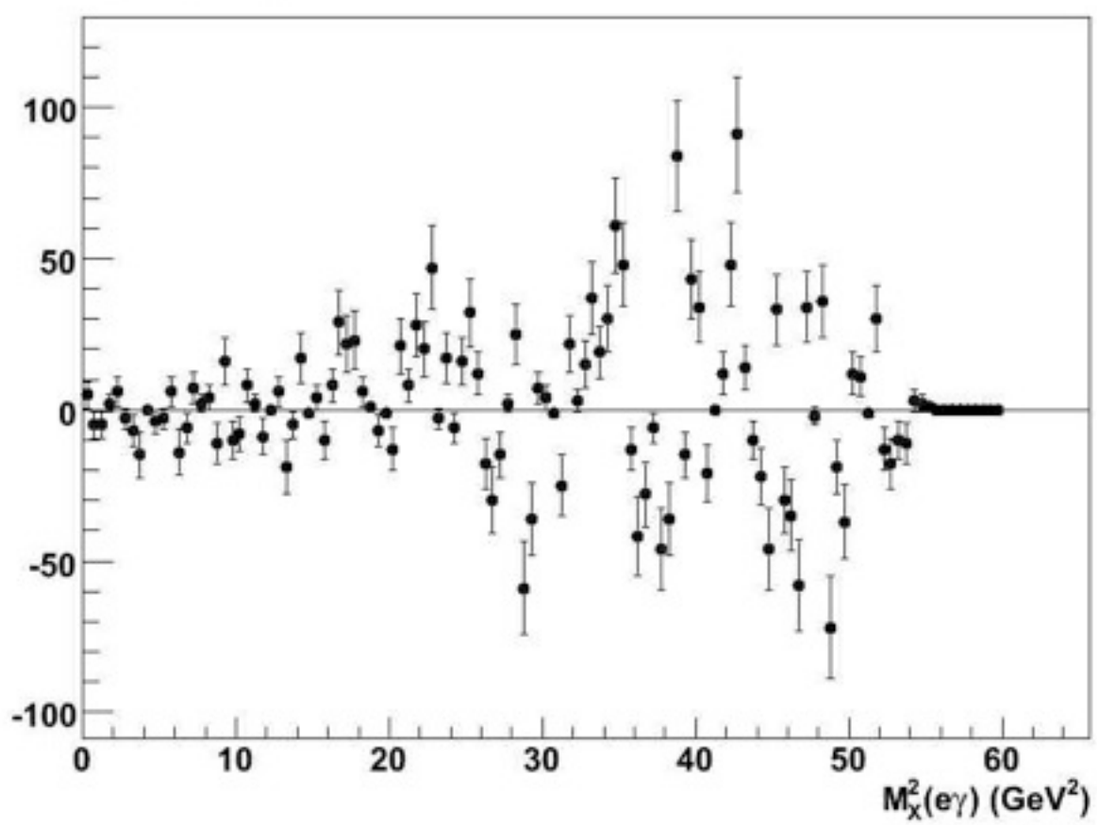
Two body breakup to proton + triton :

$e + {}^4He \rightarrow e + \gamma + p + {}^3H$

1% of the available 6GeV data are processed



Missing mass of the electron + photon with all the cuts



Helicity signal

More statistics must be processed to investigate DVCS signal

$$S_h = \int_0^{\pi} (N^+ - N^-) d\phi - \int_{\pi}^{2\pi} (N^+ - N^-) d\phi$$

High statictical fluctuations.

Conclusions

Eg6 data were taken during fall 2009 with 6GeV CEBAF polarized beam.

CLAS, the Inner Calorimeter, and a Radial TPC are used to detect the electron, the photon, and the helium nucleus.

The study of the coherent DVCS will allow to access the twist-2 Compton form factor of helium.

- RTPC calibration is still being improved
- More statistics is being processed